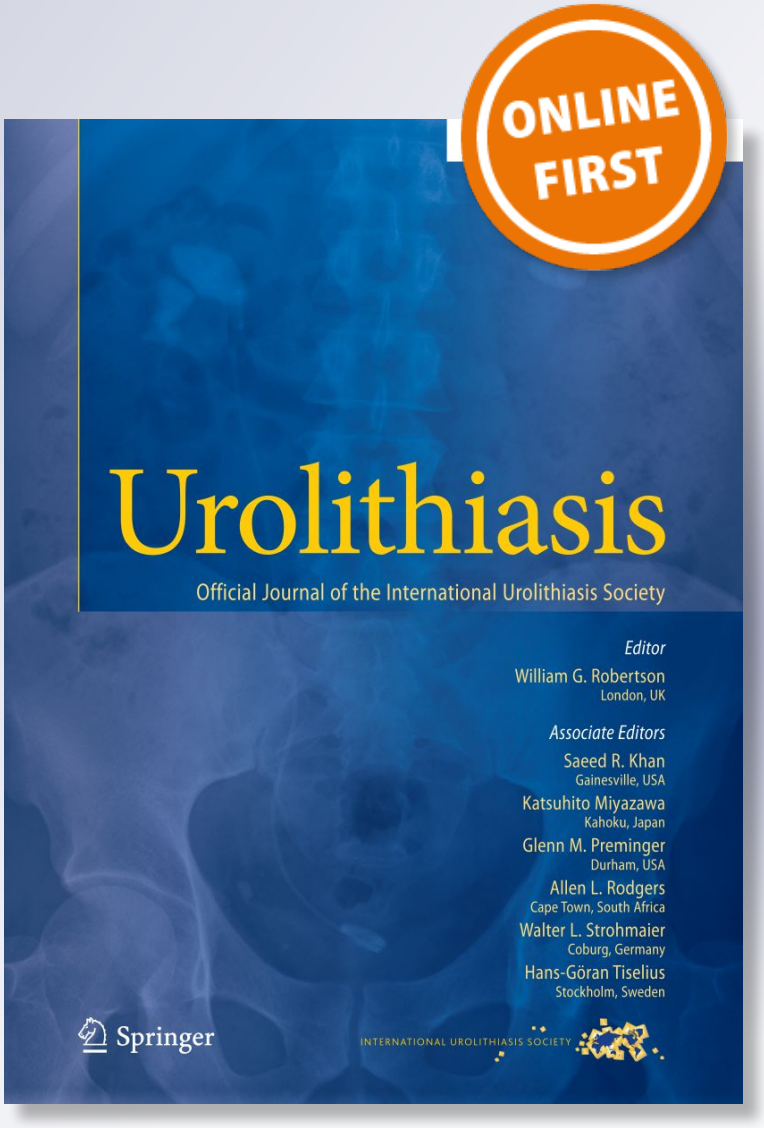
Laparoscopic and robotic surgery for stone disease

Renato N. Pedro & Noor Buchholz

Urolithiasis
Urolithiasis

ISSN 2194-7228

Urolithiasis
DOI 10.1007/s00240-017-1014-x



Springer

Urolithiasis
https://doi.org/10.1007/s00240-017-1014-x

INVITED REVIEW

Laparoscopic and robotic surgery for stone disease

Renato N. Pedro[1,3] · **Noor Buchholz**[2,3]

Received: 4 August 2017 / Accepted: 10 November 2017

Abstract
Treatment for stone disease has evolved drastically during the past 3–4 decades. Ureteroscopy, percutaneous nephrolithotomy along with SWL, provides the means to treat practically all urinary tract stones with minimal invasion to the patients. However, for complex stone case scenarios where open surgery is being considered, a less invasive and better tolerated option such as laparoscopy (robot assisted or not) can be performed. The present manuscript reviews role of laparoscopic and robotic surgery in treating urinary tract stones.

Keywords Urolithiasis · Laparoscopy · Robotics · Kidney stones · Treatment · Minimally invasive surgery

Introduction

Treatment for stone disease has evolved drastically during the past 3–4 decades. Invasive open surgeries with the corresponding long incisions have been efficiently replaced by non-invasive procedures such as extracorporeal shock wave lithotripsy (SWL) since the 1980s [1]. Moreover, the technological evolution of endoscopes and endoscopic devices has also transformed the way kidney and ureteral stones are managed. Ureteroscopy (URS), percutaneous nephrolithotomy (PCNL) along with SWL, provides the means to treat practically all urinary tract stones with minimal invasion to the patients [2, 3]. Currently, it is not surprising to affirm that the above-mentioned treatment modalities have abolished the need for open stone surgery [4].

Nevertheless, urinary tract stones can vary in size, shape, location, and, therefore, complexity, which in turn can jeopardize endoscopic access and lower stone free rates of those minimally invasive endourological approaches. For these complex stone scenarios, "cutting for stone" may still be a plausible treatment choice [5].

Similarly, to what has been described in the endoscopic field, laparoscopy has also shown an important advance in technology over the past 3 decades. Newer, better and multiple surgical laparoscopic tools, including robotics, have allowed the surgeon to reproduce open surgery concepts on a less invasive basis. Articulated needle drivers, 3D and magnified images, and Da Vinci® robotic arms have made it possible to accomplish laparoscopically the most challenging intra-corporeal sutures. Thus, much of the traditional open surgery, nowadays, has been replaced by the laparoscopic approach.

Therefore, for those complex stone case scenarios, where open surgery is being considered, a less invasive and better tolerated option such as laparoscopy (robot assisted or not) can be performed allowing for a faster recovery time [6].

The present manuscript reviews role of laparoscopic and robotic surgery in treating urinary tract stones.

Laparoscopy and robot-assisted laparoscopy for kidney stones

The AUA and EAU guidelines on urolithiasis state that for kidney stones > 2 cm, PCNL is the treatment of choice for its higher stone free rates. Whereas for stones < 2 cm, flexible URS and SWL are the first line therapy [7, 8]. There is no solid recommendation for open, laparoscopic and/or robotic surgery for kidney stones. However, the guidelines

Renato N. Pedro and Noor Buchholz share first authorship equally.

✉ Noor Buchholz
noor.buchholz@gmail.com

1 Medical Simulation and Endourology, Faculdade Medicina Sao Leopoldo Mandic, Endourology Staff UNICAMP, Campinas, Brazil

2 Sobeh's Vascular and Medical Centre, Dubai Health Care City, Dubai, UAE

3 U-merge (Urology in Emerging Countries), London, UK

Published online: 23 November 2017

mention that for complex kidney stones scenarios, such as a branched staghorn stone, an intricate collecting system, a poor functioning kidney, and a massive stone burden open or laparoscopic approaches may be suitable in selected cases [4, 7].

The current literature has increasingly demonstrated articles on laparoscopic and robotic surgeries for kidney stones as a viable option for patients with abnormal collecting system anatomy and large stone burden [9–11]. The technical evolution in manipulating laparoscopic devices and the incredible maneuverability of the robotic arm have contributed to put these surgical modalities back into the kidney stone treatment arsenal [5].

Laparoscopic pyelolithotomy (Lap-pye) has brought back the concept of open surgery, in which the renal pelvis is incised to extract the stone, at a lower distress for the patient [12]. There have been studies comparing PCNL with Lap-pye showing that the latter modality is as effective as the standard of care for kidney stones > 2 cm located at the renal pelvis, and also may provide advantages such less blood loss [13–17] (Table 1).

The combination of laparoscopic tools with endoscopic devices, such as flexible nephroscopes, enhanced the ability to reach intra-renal stones while performing Lap-pye or robot-assisted Lap-pye [18]. This resulted in better stone free rates but increased surgical costs.

Nowadays, in some centers, robotic pyeloplasty with flexible nephroscopy through the renal pelvic incision has become standard of care for UPJ obstruction with intra-renal kidney stones [19, 20].

Based on the same premises, there have been recurrent reports on robot-assisted laparoscopic anatrophic nephrolithotomy (RLap-ana) especially for complex staghorn calculi [21–23].

As in open surgery, the renal hilum has to be clamped and the parenchyma incised for stone extraction. RLap-ana mimics open anatrophic nephrolithotomy results with lower complication rates [22]. However, the need for renal artery clamping, warm ischaemia, parenchyma incision, and their repercussion on renal function has limited the use of this treatment modality for very unique scenarios [23] (Fig. 1).

Fig. 1 Bilateral branched staghorn stone

Laparoscopy and robot-assisted laparoscopy for ureteral stones

The current EAU guidelines have specified a situation where pure or robot-assisted laparoscopic ureterolithotomy (RLap-ure) is indicated as alternatives to endourological procedure for treating large obstructing ureteral stones, mainly in the advent of scarce endourological resources [7].

Laparoscopic ureterolithotomies (Lap-ure) have been compared with endourological procedures for treating large obstructing ureteral stones (> 1.5 cm) with higher stone free rates for Lap-ure [24, 25]. In addition, the advent of the robot-assisted laparoscopy has contributed for an easier intra-corporeal suturing; this fact has enabled the growing indication of RLap-ure for large obstructing ureteral stones [24, 26]. It is important to note, though, that hospital stay, operative time, and costs were higher than in the endourological surgery counterpart [24, 25].

Moreover, laparoscopy and robot-assisted laparoscopy can also have a distinctive role in patients with renal anatomic variation and stones. These surgical approaches can not only guide percutaneous renal access (in case of PCNL), but also perform the stone extraction itself [27, 28].

Table 1 Comparison of percutaneous and laparoscopic stone treatment

Authors	*N* (patients)		Stone free rate (%)		Hemoglobin drop (g/L)		Operative time (min)		Hospital stay (days)	
	PCNL	LAP	PCNL	LAP	PCNL	LAP	PCNL	LAP	PCNL	LAP
Li [13]	89	89	90	98	1.7	0.9	90	116	4.3	4.5
Al Hunayan [14]	50	55	96	100	–	–	109	131	4.4	4.5
Basiri [15]	30	30	87	90	1.88	0.85	107	149	2.2	3.4
Singh [16]	22	22	72	95	–	–	87	91	–	–
Fawzi [17]	30	30	90	100	1.8	1.1	85	133	3.4	4.1

Summarizing, endoscopic and laparoscopic surgeries have absorbed the latest in medical technology and are showing no signs of stagnation. Urologists have realized that there is a multitude of options available to address urinary stone disease. Guidelines help them comprehend their choices and better counsel their patients. The vast majority of urolithiasis can be dealt with SWL, URS, or PCNL. However, there are unique circumstances where these first line procedures will not be suitable; thus, understanding the principles of laparoscopic and robot-assisted laparoscopic procedures for kidney stone disease may play an important role in these settings. To date, there are growing scientific data supporting the use of laparoscopic approaches for large renal pelvis stone and for large obstructing proximal ureteral stones [14–18, 24–26]. Aside from these two case scenarios, laparoscopic or robotic surgeries should be considered only in complex situations where the scientific proven endourological procedures may not be or have not been successful.

Compliance with ethical standards

Funding This study had no funding.

Conflict of interest The authors declare that they have no competing interests.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

References

1. Chaussy C, Brendel W, Schmiedt E (1980) Extracorporeally induced destruction of kidney stones by shock waves. Lancet 2:1265–1268
2. Desai M, On Behalf of the Cross PCNL Study Group J et al (2011) The clinical research office of the endourological society percutaneous nephrolithotomy global study: staghorn versus nonstaghorn stones. J Endourol 25:1263–1268
3. Cohen J, Cohen S, Grasso M (2013) Ureteropyeloscopic treatment of large, complex intrarenal and proximal ureteral calculi. BJU Int 111:E127–E131
4. Preminger GM et al (2005) Chapter 1: AUA guideline on management of staghorn calculi: diagnosis and treatment recommendations. J Urol 173:1991–2000
5. Humphreys MR (2013) The emerging role of robotics and laparoscopy in stone disease. Urol Clin N Am 40:115–128
6. Wang X et al (2013) Laparoscopic pyelolithotomy compared to percutaneous nephrolithotomy as surgical management for large renal pelvic calculi: a meta-analysis. J Urol 190:888–893
7. Türk C et al (2016) EAU guidelines on interventional treatment for urolithiasis. Eur Urol 69:475–482
8. Assimos D et al (2016) Surgical management of stones: American Urological/Endourological Society Guideline Part I. J Urol 196:1153–1160
9. Stein RJ et al (2008) Laparoscopic pyeloplasty with concomitant pyelolithotomy: technique and outcomes. J Endourol 22:1251–1255
10. Tan YK, Cha DY, Gupta M (2013) Management of stones in abnormal situations. Urol Clin N Am 40:79–97
11. Zhou L et al (2011) Retroperitoneal laparoscopic anatrophic nephrolithotomy for large staghorn calculi. Int J Urol 18:126–129
12. Salvado JA et al (2009) Laparoscopic pyelolithotomy: optimizing surgical technique. J Endourol 23:575–578
13. Li S et al (2014) Randomized controlled trial comparing retroperitoneal laparoscopic pyelolithotomy versus percutaneous nephrolithotomy for the treatment of large renal pelvic calculi: a pilot study. J Endourol 28:946–950
14. Al-Hunayan A et al (2011) Management of solitary renal pelvic stone: laparoscopic retroperitoneal pyelolithotomy versus percutaneous nephrolithotomy. J Endourol 25:975–978
15. Basiri A et al (2014) Comparison of safety and efficacy of laparoscopic pyelolithotomy versus percutaneous nephrolithotomy in patients with renal pelvic stones: a randomized clinical trial. Urol J 11:1932–1937
16. Singh V, Sinha RJ, Gupta DK, Pandey M (2014) Prospective randomized comparison of retroperitoneoscopic pyelolithotomy versus percutaneous nephrolithotomy for solitary large pelvic kidney stones. Urol Int 92:392–395
17. Fawzi AM, Ali AR, Shello HE et al (2015) Retroperitoneal laparoscopic pyelolithotomy versus percutaneous nephrolithotomy for treatment of renal pelvis stones: a prospective randomized study. Eur Urol Suppl 14:e588
18. El-Kappany HA et al (2007) Combination of laparoscopy and nephroscopy for treatment of stones in pelvic ectopic kidneys. J Endourol 21:1131–1136
19. Mufarrij PW et al (2008) Robotic dismembered pyeloplasty: a 6-year, multi-institutional experience. J Urol 180:1391–1396
20. Skolarikos A, Dellis A, Knoll T (2015) Ureteropelvic obstruction and renal stones: etiology and treatment. Urolithiais 43:5–12
21. Giedelman C et al (2012) Laparoscopic anatrophic nephrolithotomy: developments of the technique in the era of minimally invasive surgery. J Endourol 26:444–450
22. King SA, Klaassen Z, Madi R (2014) Robot-assisted anatrophic nephrolithotomy: description of technique and early results. J Endourol 28:325–329
23. Ghani KR et al (2013) Robot-assisted anatrophic nephrolithotomy with renal hypothermia for managing staghorn calculi. J Endourol 27:1393–1398
24. Kumar A et al (2014) A prospective randomized comparison between laparoscopic ureterolithotomy and semirigid ureteroscopy for upper ureteral stones > 2 cm: a single-center experience. J Endourol. https://doi.org/10.1089/end.2013.0791
25. Basiri A et al (2008) Retrograde, antegrade, and laparoscopic approaches for the management of large, proximal ureteral stones: a randomized clinical trial. J Endourol 22:2677–2680
26. Dogra PN et al (2013) Lower ureteral stones revisited: expanding the horizons of robotics. Urology 82:95–99
27. Nayyar R, Singh P, Gupta NP (2010) Robot-assisted laparoscopic pyeloplasty with stone removal in an ectopic pelvic kidney. JSLS 14:130–132
28. Elbahnasy AM (2011) Laparoscopic pyelolithotomy in selected patients with ectopic pelvic kidney: a feasible minimally invasive treatment option. J Endourol 25:985–989